

Dingxi Prefecture of Gansu Province' s development of rainwater collection and water-saving irrigation to combat the arid environment

Xiaojun Zhang^{a,c}, Suocheng Dong^a, Haiying Wang^a, Guihuan Liu^a, Shuang Li^{a,b},

a Institute of Geographical Sciences and Natural Resources Research
Chinese Academy of Sciences Beijing 100101, China

b College of Environment and Planning, Henan University, Kaifeng, Henan 475001, China

c. YenChing Real Estate Institute of Beijing Union University

ABSTRACT

Dingxi prefecture is located in foothill of the Loess Plateau, where the climate is arid or half-arid. Due to the intrinsic atrocious eco-environment, Dingxi prefecture has been facing the vicious circle of eco-environmental vulnerability and poverty in a long time. At the same time, in the long-time practice, Dingxi has taken the rainwater collection and water-saving irrigation as the link of improving eco-environment and increasing field' s productivity, and energetically developed high-yielding ecological agriculture, which offered a new way for solving the problem of agricultural development in the arid or half-arid region. This paper intensively studied the content including engineering system, technological system and social economic systems, and etc), the composite mode of rainwater collection and utilization in different landforms (such as in the court of a farm-house, along a small valley, or in the field), and the economic, social and ecological benefit of developing ecological agriculture in Dingxi prefecture, whose marked characteristic is rainwater-collection and water-saving irrigation and high-yielding. In the end, finding a solution to the existing problems, the author put forward some countermeasure, aiming at offering scientific reference for the same region to develop ecological agriculture.

Key words: Dingxi prefecture, Rainwater collection, Water-saving irrigation , Ecological agriculture

1. INTRODUCTION

The technology of rainwater collection & irrigation now has become a key project in the water scarce regions, which are now facing the problem of water shortage and the requirement

Of sustainable development, especially there are so many field practices in the arid areas of Israel, Australia, and America. ^[1] Dingxi Prefecture is located in the semi-arid area on China' s Loess Plateau, in its long history of practice; the local residents have developed the rainwater collection & water-saving irrigation as the linkage between the land productivity and the eco-environment amelioration. The high efficiency agriculture water using model named Six Elements Integrated have become the paradigm for other regions, which comprises the terrace, water cellar, field theca, micro-irrigation, qualified seeds and fertility ^[2-5]. The fundamental principal Analyzing from the agriculture production point of view, the factors that influence the output mainly are the four

elements, i.e. solar light, temperature, water and soil fertility. Generally, in the semi-arid area there are plenty of sun shining, and suitable temperature, so it was water and fertility that fundamentally constrain the output of agriculture ^[2]. The local residents effort have improved that the rainwater collection & water-saving irrigation projects not only can effectively use the rainwater ,

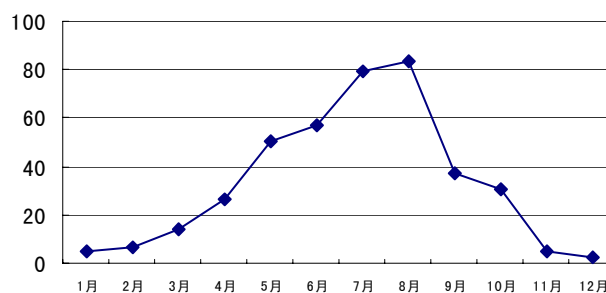


Fig1: Seasonal distribution of precipitation in Dingxi Prefecture

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 25 JUL 2005		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Dingxi Prefecture of Gansu Provinces development of rainwater collection and water-saving irrigation to combat the arid environment				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institute of Geographical Sciences and Natural Resources Research Chinese Academy of Sciences Beijing 100101, China				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM001850, 2005 IEEE International Geoscience and Remote Sensing Symposium Proceedings (25th) (IGARSS 2005) Held in Seoul, Korea on 25-29 July 2005. , The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

but also alleviate the lost of soil and the menace of drought, in this way a benign circle of agriculture ecological system is established and the sustainable development of primary industry has been realized^[3-5].

It is an important way to resolve the dilemma between the eco-environmental vulnerability and the economic poverty. In the long history Dingxi Prefecture had faced the bi-crisis, the eco-environmental vulnerability and the economic poverty. Though there are little rain fall in Dingxi, the advantage condition here is that the rain fall is mainly converged in the range from June and September, the sloppy land is a natural water abundant season, this kind of landform is beneficial for the rainwater collection. The local people can build the water cellar or pool on the top of the slop to easily self-flowing into the down areas, not needing to build the water lifting & aqueduct facilities. The previous research has showed that the soil water from May to June in Dingxi is in the lowest level of the total year. On the technology of the rainwater collection & water-saving irrigation, the local farmers have accumulated one thousand years' experience, so the traditional water & soil measures are almost perfect.

2 The development history of rainwater collection & water-saving irrigation agriculture in Dingxi Prefecture

2.1.1 the “121” project of rainwater collection

In the year of 1995, Dingxi Prefecture has being implemented the “121” project to resolve the local people's & livestock's drink water according to the deployment of Gansu Province government, which boasted to build a rainwater collection area of 100m², two water cellars and a county yard economy per household.

2.1.2 The rainwater collection & water-saving irrigation project

From 1997, Dingxi Prefecture administration has extended the rainwater collection project which mainly focus on the resolving the drink

water problems to the re-irrigation project in farm land.

2.1.3 “2 heights & 1 advanced” modern agriculture

Based on the rainwater collection & water-saving irrigation projects, Dingxi Prefecture had also developed the “2 heights & 1 advanced” modern agriculture. With the long history of practice on the rainwater collection, the fundamental condition of primary industry and the local people's living condition has been largely improved in Dingxi Prefecture.

2.2 the deploy model of rainwater collection & water-saving irrigation agriculture

2.2.1 project in the household yard

This is just the famous “121” project, which mostly take the famer's household roof as the rainwater collection area, and construct the assistant collection field in the vacant ground or between the farm land, and the concrete water cellar is built according to the scale of the collection field at the yard's or shed's water gap. (Fig.2)

2.2.2 project along the road

This means to construct the higher altitude water vault along the road, and build manual aqueduct to collect the road surface runoff to develop the efficient farm land irrigation, the collected rainwater along the rural road mainly used as the makeup of water supply for farm land, in some areas which have condition to build orchard and sunlight warm house supply water for the make up of vegetable.

2.2.3 Project in the watershed

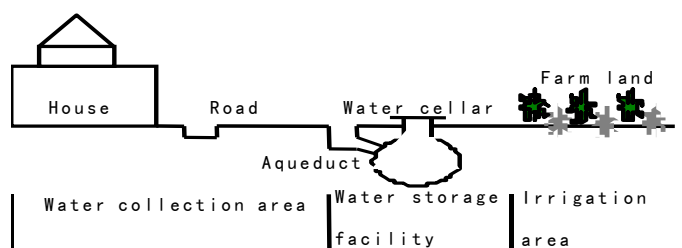


Fig2: Mode of rainwater collection and utilization along the courtyard of a farm-house

This means to combine the technology of rainwater collection and utilization with traditional technology of irrigation works and water conservation, e.g. terrace, strip land, etc. to distribute rationally the net of dyke, ditch, pipe, to collect the runoff on the slope, road and manual water collection field, to storage the water in the water cellar, dam sluice project. (Fig.3 rain water collection project along valley)

2.2.4 Project in the field

This means to accumulate the precipitation in the field, which belongs to the cultivating technology model.

2.3 Benefit analyst

2.3.1 Economic benefit

According to the relevant tests, the water quota for wheat under theca is $975\text{m}^3/\text{hm}^2$, and the per unit area of output will increase about $2250\text{kg}/\text{hm}^2$. the maize under theca and equipped with the oozing & dropping irrigation need only 5~6 times during its bearing phase, and the water quota is $750\text{m}^3/\text{hm}^2 \sim 1080\text{m}^3/\text{hm}^2$, and the per unit area of output will increase about $3000\text{kg}/\text{hm}^2$ ^[6].

2.3.2 rainwater collection project subsystem

This system is composed by three linked projects, which are water collection project, storage & adjust project, and the utilization project formed into an integrated and efficient collecting & storing & water-saving irrigation system.

2.3.3 water-saving & biotechnology agriculture subsystem

The water-saving agriculture is composed of

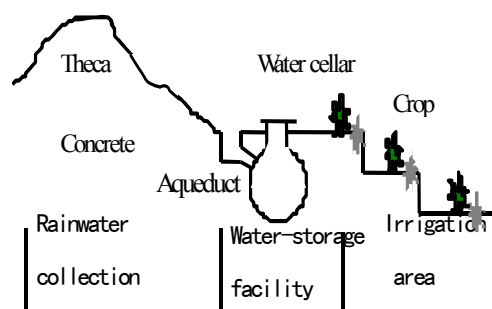


Fig.3 Dingxi Prefecture's water collection project along valley

three linkages, i.e. water-saving cultivating technology, water-saving project technology, and water-saving irrigation technology and is equipped with the integrated biotechnology^[6].

2.3.4 the socio-economic & management subsystem

There was a scientific combination of the rainwater collection & water-saving irrigation agriculture VS the high efficient rural socio-economic & management system in Dingxi Prefecture practice

2.4 Benefit analyst

2.4.1 Economic benefit

the most direct benefit of the development of rainwater collection & water-saving irrigation agriculture is the incensement of the land output value. According to the relevant tests, the water quota for wheat under theca is $975\text{m}^3/\text{hm}^2$, and the per unit area of output will increase about $2250\text{kg}/\text{hm}^2$. the maize under theca and equipped with the oozing & dropping irrigation need only 5~6 times during its bearing phase, and the water quota is $750\text{m}^3/\text{hm}^2 \sim 1080\text{m}^3/\text{hm}^2$, and the per unit area of output will increase about $3000\text{kg}/\text{hm}^2$ ^[24].

2.4.2 Social benefit

(1) The rainwater cellar's construction fundamentally solved the local people's and livestock's drink water^[7]. (2) The traditional self supplied agriculture was transformed into the modern commercial agriculture. (3) The rural spirit civilization construction was developed. (4) The government also has got the benefit^[8].

2.4.3 Environmental benefit

For the rainwater collection projects can sufficiently sluice the surface runoff, and equipped with the small watershed synthetic management program, the soil & water lost was effectively reduced and they both were well conserved, and for the food now can be self-supplied, so the local farmers needn't to reclaim the wild land on the steep slop.

3 existing problems and the policy proposals

⁴⁾ Ding Xi Prefecture's ninth five-year plan about the water saving and irrigation projects plan, 1996No.081.

3.1 the main problems in the rainwater collection and utilization^[1]

(1) the traditional way, which comprises laggard technology, dominates the most proportion. (2) the popularization of advanced technology still needs time.

(3) the synthesis and systematic technology system is not on the state.

3.2 policy proposals

(1) Widen the channel of capital, and guarantee the investment.

(2) strengthen the relative fundamental science research.

(3) Popularizing the advance facilities.

(4) Pay attention to the organic combination of the irrigation, ecological construction, arid cultivating measures and the adding productivity measures in a coupling way.

(5) Promote the industrialization of the rainwater collection & water-saving irrigation agriculture.

(6) Spread the rainwater collection from the rural areas to the urban areas.

Conclusions

It has proved an efficient way to improve the field's crop productivity by collecting rainwater in the arid and semi-arid areas, where the soil water is always in a deficient state but still can promise certain quota of rain. The local resident's response and practice also improved that the rain-collecting agriculture is a new strategy to resolve the problem of arid area's agriculture industry. In this way, the original space & time discontinuously distribution and unstable precipitation have been transformed into a kind of sustainable and stable water supplier, at the same time the native agriculture also has transformed from the kind of passive adapt into a kind of positively fighting against the drought. On the other hand, the rainwater collection & water-saving irrigation agriculture has promote the regulation of primary industry's economic structure and has

realized the consolidation between the protection & renew of the natural ecological environment and the stabilization of the production activity of the agriculture industry. So in the strategy of western development, this kind of ecological agriculture industry, i.e. the rainwater collection & water-saving irrigation agriculture offers successful paradigms for the other regions, which have the same natural conditions and face the same problems.

References

- [1] YU Fawen Research on the rainwater collection and utilization in half arid area on Loess Plateau of China[J], Ecological economic communication, 2002, (4):1~7
- [2] GUO Jianping, Agricultural development and efficient utilization of agroclimatic resources in western region of China[J], Resources Science, 2002, 24 (2) : 22~25
- [3] DING Shengyan Suitability assessment for area of rainwater harvesting agriculture[J], Resources Science, 2003, 25 (2) : 51~55
- [4] ZHANG Yifeng Research progress on arid-land agriculture in northern China[J], Geographical Research, 2002, 21 (3) : 305~312
- [5] ZHAO Xuyan, BA Jianjun Strategy of ecological construction and sustainable agriculture development of Loess Plateau in Gansu province, China[J], Arid Land Geography, 2002, 25 (4) : 346~349
- [6] CAO Guofan, Research on the agriculture of rainwater harvesting and economical supplementary irrigation in semi-arid area, Lanzhou: Scientific Technology Press of Gansu province, 2001
- [7] YU Fawen SHANG Jie Research on the sustainable development of agriculture in half arid area of western China[J], Rural Economics in China, 2001(10):54~58
- [8] ZOU Lan and WANG Tianguang, Rainwater collection: Development, Anti-Poverty and Environment[J], Practice of Sustainable Development in China[M], Beijing: Economic Science Press, 2002